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Working Paper

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Discussion Paper, No. 253

Provided in Cooperation with:
University of Munich (LMU) and Humboldt University Berlin, Collaborative Research Center Transregio 190: Rationality and Competition

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August 14, 2020

Collaborative Research Center Transregio 190 | www.rationality-and-competition.de
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Face masks increase compliance with physical distancing recommendations during the COVID-19 pandemic*

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Abstract

Governments across the world have implemented restrictive policies to slow the spread of COVID-19. Recommended face mask use has been a controversially discussed policy, among others, due to potential adverse effects on physical distancing. Using a randomized field experiment (N=300), we show that individuals keep a significantly larger distance from someone wearing a face mask than from an unmasked person. According to an additional survey experiment (N=456), masked individuals are not perceived as being more infectious than unmasked ones, but they are believed to prefer more distancing. This result suggests that, in times where mask use is voluntary, wearing a mask serves as a social signal for a preferred greater distance that is respected by others. Our findings provide strong evidence against the claim that mask use creates a false sense of security that would negatively affect physical distancing.

Keywords: COVID-19; Health Policy; Compliance; Face Masks; Risk Compensation; Field Experiment

JEL Codes: C93, D9, I12

*We are grateful to the members of the Berlin Behavioral Economics research group and seminar participants at HU Berlin for their valuable comments. Financial support by Deutsche Forschungsgemeinschaft through CRC TRR 190 (project number 280092119) is gratefully acknowledged. The online survey was financed through project funds of the Einstein Center Digital Future.

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1 Introduction

Since its first occurrence in late 2019, the coronavirus SARS-CoV-2 had spread to nearly all countries, infected more than 10 million people, and had claimed more than 500,000 lives by the end of June 2020 (CSSE, 2020; Dong et al., 2020). As SARS-CoV-2 is most commonly spread via droplets from the mouth or nose, public health authorities recommend regular and thorough hand hygiene, proper coughing and sneezing etiquette, and keeping a safe distance to others (BMG, 2020; WHO, 2020c). In addition to universally agreed-upon sanitary and social distancing measures, the use of face masks by the general public is a potentially effective but highly debated policy. Not only does the use of face masks by the public vary widely across countries (Belot et al., 2020; IPSOS, 2020) but so do official recommendations (Feng et al., 2020). On April 6, the World Health Organization advised that "The use of medical masks in the community may create a false sense of security, with neglect of other essential measures, such as hand hygiene practices and physical distancing..." (WHO, 2020b). Despite these claims, by the end of April, many countries, including all German federal states, have made the use of face masks mandatory in stores and public transport. In the same spirit, the Center for Disease Control and Prevention in the US recommends covering one's face in public where keeping a safe distance is not feasible (CDC, 2020). On the other hand, Danish and Norwegian authorities, among others, are decidedly not recommending the use of face masks for healthy people (Danish Health Authority, 2020; Iversen et al., 2020). The World Health Organization adjusted its position during the outbreak, by May acknowledging that masks can limit the spread of the virus although their use alone offers insufficient protection (WEF, 2020; WHO, 2020a). Despite the contradicting policies, the face mask debate lacks conclusive evidence on how mask wearing affects social distancing.

The argument for mandatory face masks is based on studies that found masks to effectively reduce the spread of pathogens when they are worn by infected individuals (van der Sande et al., 2008; Rengasamy et al., 2010; Suess et al., 2012; Saunders-Hastings et al., 2017; Mitze et al., 2020; Leung et al., 2020). Using this evidence, statistical simulations have shown that the universal wearing of a face mask is shown to be an effective preventive tool (Eikenberry et al., 2020) until antibody testing can distinguish between healthy and sick individuals, as some individuals remain asymptomatic although having contracted the disease. These results are important as SARS-CoV-2 is transmitted also via aerosol (Bahl et al., 2020; Setti et al., 2020). Additionally, as suggested by Howard et al. (2020), seeing a mask may serve as a reminder to comply with precautionary measures.

The main argument against compulsory face masks emphasizes potentially counterproductive effects from incorrect use, supply shortages, and a false sense of security (WHO, 2020a). While supply shortages have been largely addressed and the improper use of masks can be mitigated with training (Javid et al., 2020), there is little evidence for or against the argument that face masks give individuals a false sense of security that would lead to reduced efforts in other precautionary measures. However, there are good arguments to expect such a behavioral backlash. Indeed, masks protect others from infection who can reduce their own preventive efforts in a form of moral hazard (Zweifel and Manning, 2000). Similarly, individuals may engage in risk compensation and react to the reduced infection risk from others wearing masks by taking higher risks themselves (Wilde, 1982). Evidence on risk compensatory behavior in the context of HIV prevention (Eaton and Kalichman, 2007; Marcus et al., 2013; Wilson et al., 2014), seat-belt laws (Evans and Graham, 1991; Cohen and Einav, 2003; Houston and Richardson, 2007), and bicycle helmets (Adams and Hillman, 2001) is mixed. Studies from the early phase of the COVID-19 pandemic find that compliance with social distancing mandates varies with perceived risk and that individuals differ substantially in their risk perceptions (Ajzenman et al., 2020; Allcott et al., 2020; Grossman et al., 2020; Harper et al., 2020; Larsen et al., 2020; Rosenfeld et al., 2020; Wise et al., 2020). In contrast to perceived risk, objective risk or social preferences appear to have little effect on (non-)compliance (Canning et al., 2020; Sheth and Wright, 2020; Harper et al., 2020). However, due to a potential bias toward socially desirable behaviors (Krumpal, 2013; Larsen et al., 2020) or anchoring on widely endorsed behavioral recommendations regarding the safe distance (Kahneman, 2011), it is uncertain to which extent survey studies reflect actual behaviors.

Given the possibility of behavioral backlash from masking, it is pertinent for the current policy debate to gain insights into how individuals adjust their behavior to masking (Greenhalgh et al., 2020). To this end, we contribute to the scientific debate on face mask policies a behavioral perspective. Specifically, we study the effect of masking on physical distancing with a combination of a randomized field experiment and a complementing online survey to examine (1) whether individuals keep a shorter distance to someone who wears a mask and (2) what are the potential reasons behind this behavior. In doing so, we focus on three possible mechanisms. First, wearing a mask can be perceived as a sign of being sick or infectious because authorities recommend that symptomatic individuals wear masks (ECDC, 2020; WHO, 2020b). If people who know they are sick with a respiratory disease are more inclined to wear a mask to protect others, a mask becomes a signal for infectiousness and it is sensible to stay further away from them as a precaution. Second, wearing a mask can be perceived as a sign of awareness toward the pandemic. People who are taking the virus more seriously may want other people to keep a greater distance. Hence, staying further away would be a gesture of respect for others' preferences or reflect a tendency to conform to social expectations (Bernheim, 1994; Cialdini and Goldstein, 2004). Third, a mask can also serve as a reminder of the current pandemic. If insufficient distancing between individuals results from inattention, masks can cue the public health rules and serve as a reminder (Howard et al., 2020). To our knowledge, only one study (Marchiori, 2020) tested the effect of personal protective equipment on physical distancing, finding no evidence of risk compensatory behavior.

Our study is related to Marchiori (2020) who tested the effect of personal protective equipment on physical distancing on sidewalks, finding no evidence of risk compensatory behavior.[1] However, our experiment was carried out in lines in front of stores, where there is evidence of infection (Qian et al., 2020), and mask use was recommended by authorities at the time of measurement. Furthermore, we provide additional insights about distancing with a corresponding online survey experiment.

2 Field experiment

In our first study – a randomized field experiment with N = 300 – we test whether people keep a different distance from individuals with or without a mask when waiting outside a business.[2] Before arriving at the study site, experimenters wore a mask (Treatment Mask) or not (Treatment NoMask) based on a coin toss. Upon data collection, the experimenter took the last position in a waiting line outside a store, supermarket, or post office. When the next customer arrived and took a position in the line after the experimenter, the experimenter measured the distance between themselves and the arrived customer. The measurement was taken with a light detection and ranging app on a mobile device.[3] None of the stores had delineated markings for distance for the lines. After the measurement was completed, the experimenter moved out of the line, stepped away, recorded the observation, then returned to the end of the line. The study was conducted in Berlin, Germany, between April 18 and April 24, 2020, before wearing a face mask became mandatory in stores. All data was collected by five experimenters, who acquired 60 independent observations each, balanced across the two treatments. The details of experimental procedures can be found in the supplementary materials.

Comparing the age groups of the sample from our field experiment to the city's population shows that the 60+ group is underrepresented (10,7% vs. 24,7%), a likely consequence of that seniors contracting the virus are known to face higher death rates. However, our sample is meant to represent the relevant population leaving their homes. Furthermore, as we did not observe any age-related effect on distancing, we believe our observations represent population characteristics well. Our sample was representative in terms of gender (51.3% vs. 50.8% in the population).

On average, subjects kept a distance of 157.2 cm from the experimenter, thus slightly exceeding the mandated minimum distance of 150 cm (z=3.565, P<0.01, 2-sided Wilcoxon

[1] The two studies were conducted in overlapping time periods and independently.

[2] Before collecting the data, we did not have a directed hypothesis regarding the effect of wearing a mask on distances. See the preregistration of the field experiment for details: `https://doi.org/10.1257/rct.5735-1.0`.

[3] The measurement was not obvious to the subjects, took 5-20 seconds, and we did not record any instance when they were clearly aware of it.

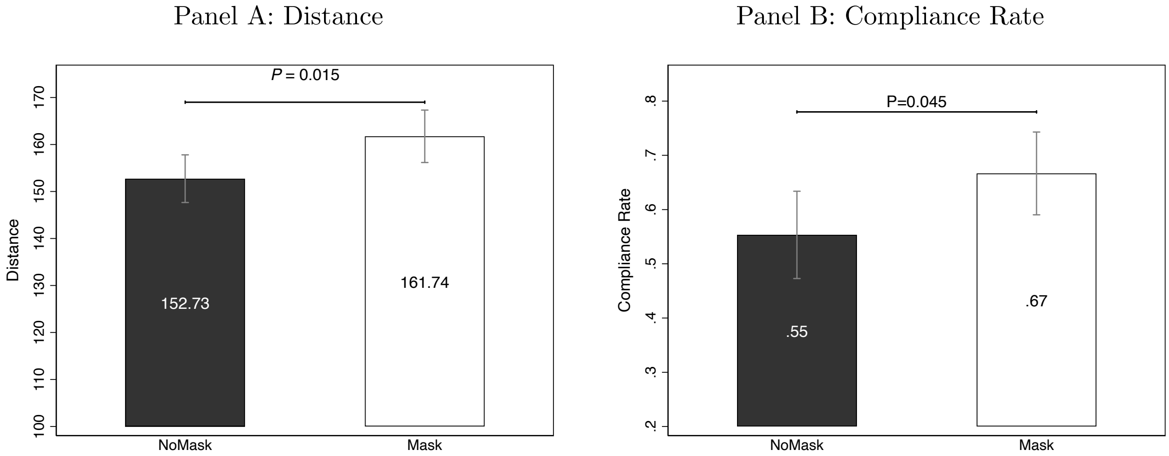

Figure 1: **Effect of Mask on Distancing.** Panel A shows the average distance kept by subjects in the field experiment in NoMask and Mask treatments. Panel B shows the compliance rate. Standard errors bars. P-values report the results of a 2-sided Mann-Whitney U test.

signed-rank test). However, individual distances vary substantially, ranging from 55 to 275 cm (SD=33.3 cm). In the sample, only 61% comply with the mandate and stand at least 150 cm away from the experimenter.

As shown in Fig.1, the average distance that individuals keep to the experimenter and the compliance rate with the distancing mandate of 150 cm both significantly increase in the treatment Mask compared to the NoMask condition. The average distance is 5.9% or 9 cm larger if the experimenter is wearing a mask (161.7 cm vs. 152.7 cm, z=-2.439, P=0.015, 2-sided Mann-Whitney U test) and non-parametric kernel density estimates confirm a positive shift in distancing (D=0.1933, P <0.01, 2-sided Kolmogorov-Smirnov test). Table 1 reports the estimated coefficients of different regression specifications with the distance to the experimenter as the dependent variable. In general, we observe a significantly positive effect of the Mask treatment on the distance (P <0.10). The statistically significant increase in average distance in the Mask treatment suggests that the argument of masks inducing a false sense of security does not apply when individuals approach a masked person.[4].

Around 17% of the subjects were wearing a mask themselves. If wearing a mask gives them a false sense of security, then the mask use of other people should be less relevant to them. Similarly, if masks serve as a reminder, people who wear a mask themselves are more likely to be alerted to the pandemic. Therefore, we would expect them to react less to the treatment variation. To the contrary, model (4) of Table 1 reveals that the effect of the experimenter having a mask is somewhat stronger but not significantly different for subjects who wear a mask themselves compared to subjects who do not

[4]We account for heteroscedasticity created by locations and date of measurement and for the relatively small number of clusters, we run a bootstrap cluster regression. The resulting p-value for the Mask Experimenter variable in model (4) in Table 1 is 0.068, suggesting robustness of our results to clustering.

Table 1: Treatment effect on the physical distancing

Dependent variable: Distance in cm	(1)	(2)	(3)	(4)
Mask Experimenter	8.519**	8.431**	8.539**	6.841*
	(3.757)	(3.688)	(3.686)	(4.103)
Mask Subject	14.83**	13.59**	12.32*	6.953
	(4.904)	(5.207)	(5.358)	(6.116)
Mask Experimenter × Mask Subject				10.12
				(9.906)
Accompanying Adult			-11.81**	-11.31*
			(4.970)	(4.994)
Accompanying Child			2.407	2.416
			(5.638)	(5.637)
Gender of Subject			3.092	3.226
			(3.792)	(3.794)
Population Density of Neighborhood			-0.00129*	-0.00129*
			(0.000919)	(0.000919)
Constant	150.5***	159.9***	178.7***	178.6***
	(2.772)	(7.746)	(15.36)	(15.36)
Control Variables	No	Yes	Yes	Yes
Observations	300	300	300	300
R^2	0.046	0.137	0.162	0.165

Notes: Ordinary least squares estimates. Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Mask Experimenter and Mask Subject are indicator variables for whether the experimenter or subject, respectively, used a face mask. Gender=1 if the subject is female. Accompanying Adult and Accompanying Child indicate whether the subject was accompanied by at least one other adult or child, respectively. Population density is based on the 2011 German Census data. Control variables are age groups, store types, and experimenter fixed effects.

wear a mask. Thus, we do not find any evidence of moral hazard, risk compensation, or reminder effects of the face masks. This result may not extrapolate to a situation with mandatory masking, as subjects wearing a mask voluntarily may differ from the rest of the sample in unobserved dimensions that could influence the distance they keep from others. Moreover, being a self-selected sample, we cannot postulate a causal effect of masks on distance keeping.

We further note that subjects who are in the company of other adults come closer to the experimenter than those who are alone. A possible reason is that adult company reduces the attention paid to maintain safe distances from others because they are, e.g., talking to each other. However, it could also be the case that individuals who are likely to violate the physical distancing rule also take the social distancing rules less seriously and are more likely to be in public places together with others.[5] Our data does not allow to distinguish between these factors.

[5]At the time of the experiment, citizens of Berlin were asked to avoid any unnecessary social contact with individuals from other households.

3 Survey experiment

Having found a positive causal effect of face masks on physical distancing, we next investigate potential explanations for this result in a survey experiment with N = 456. The survey was conducted online in German with a German-resident sample on www.prolific.co on April 26, 2020, before federal face-covering mandates came into force in Germany.

First, each respondent was randomly exposed to an original photograph of an experimenter either with (Mask treatment) or without a mask (NoMask treatment).[6] Then, respondents were asked to imagine the person pictured in a waiting line outside of a post office and estimate (i) the distance to this person at which another person joining the line would come to stand (in cm); (ii) the distance the person pictured would prefer the arriving person to keep from him or her (in cm), and (iii) how likely it is that the person pictured is sick or (iv) infectious (on a 7-point Likert scale). Next, respondents were asked to guess the average or modal, respectively, answers of other survey participants to the same questions. We rewarded each correct guess with a bonus of 0.20 EUR (see S2.1 for details). Finally, the respondents were asked to estimate which distance subjects in the past field experiment had kept from the person pictured on average (in cm; again, we rewarded each estimate within 5 centimeters of the actual distance with a bonus 0.20 EUR). This approach allowed us to ensure that the respondents had made a significant effort to answer the questions correctly. It also informs us about the beliefs individuals hold about the public perception of the tested situation.

The survey respondents do not predict the average distance toward the masked experimenter will be shorter than compared to the unmasked experimenter (144.07 cm vs. 138.82 cm, z=-0.777, P=0.437, 2-sided Mann-Whitney U test, Fig. 2 A). Thus, the survey respondents recognized that a face mask did not induce subjects to allow for shorter distances to the masked experimenter, but they underestimated a mask's positive effect on the distance kept.

We fail to find evidence that people perceive a masked person as more likely to be sick or infectious than a person without a mask (Fig. 2 B). To the contrary, experimenters in Mask were perceived as less likely sick (z=1.981, P=0.0475, 2-sided Mann-Whitney U test) and as less likely infectious (z=3.631, $P<$0.01). Therefore, we rule out that a mask serves as a sign of someone being sick or infectious and therefore motivating other people to stay further away to avoid infection.

Next, we examine the role of the estimated preferred distance of the experimenter in explaining the results of our field experiment. For this mechanism to be effective, it must be (i) that people who wear masks are perceived as individuals who prefer to keep larger distances away from others and (ii) that this perception induces others to maintain larger

[6]Original photographs are available upon request.

Panel A:
Estimated Distance

Panel B:
Perceived Health of the Person Pictured

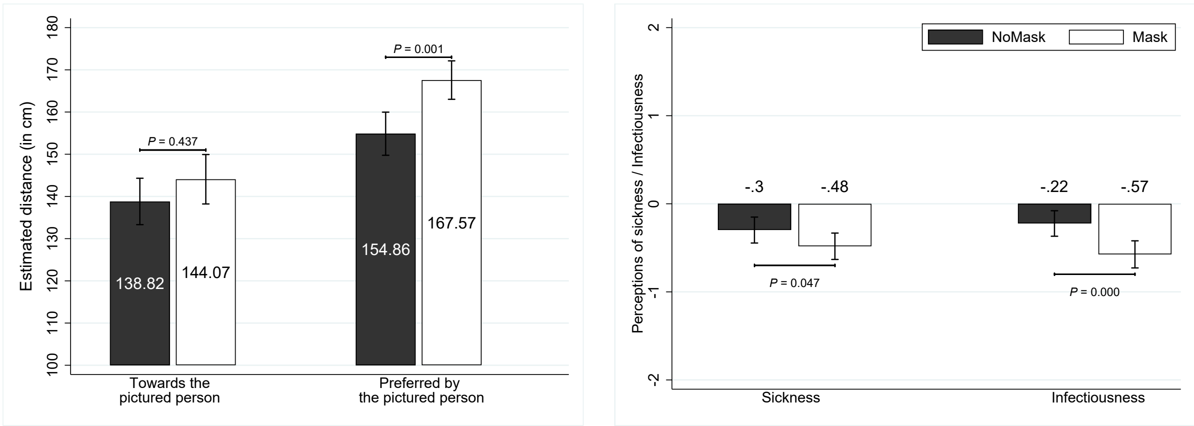

Figure 2: **Testing Channels with Survey Respondents.** The left panel pictures the estimated average distance that was kept in the field experiment and beliefs about the average perception of other respondents about the preferred distance in treatments Mask and NoMask. The right panel illustrates the chances of the person pictured being sick or infectious in treatments Mask and NoMask. -3 stands for "definitely not sick" or "definitely not infectious," 0 stands for "I'm not sure" and 3 stands for "definitely sick" or "definitely infectious'.' The P-values are based on the results of the 2-sided Mann-Whitney U test. All values in Panel B are significantly different from zero (P <0.05, 2-sided Wilcoxon signed-rank test.)

distances. To test for step (i), we compare across treatments the respondents' perception of the preferred distance that the pictured experimenter would like others to keep from them. Respondents in Mask, on average, believed that the experimenter with a face mask preferred a distance of 167.57 cm. In NoMask, the average answer to this question was 154.86 cm. Both values lie significantly above the threshold of 150 cm (P <0.02, 2-sided Wilcoxon signed-rank test). The treatment effect on this variable is statistically significant (z=-3.205, P<0.01, 2-sided Mann-Whitney U test).

To examine (ii), we test whether respondents' estimates of the average distance maintained by subjects in our field experiment can be predicted by their perception of the preferred distance of the pictured experimenter. Figure 3 provides a graphical illustration of the regression results reported in Table S4. All coefficients are positive and almost all are significant. The results suggest that respondents who estimated the person pictured would to prefer a larger physical distance also stated higher estimates for the distance kept by the subjects in the field experiment. This effect is especially pronounced in the Mask treatment. This observation suggests that the preference for longer distances signaled by a mask can successfully trigger greater distancing.

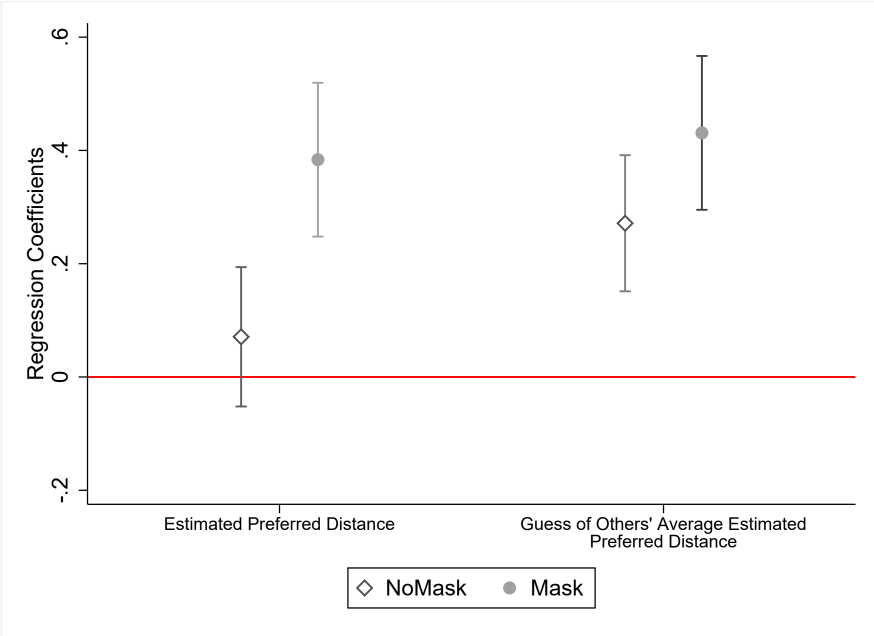

Figure 3: **Responsiveness of the respondents' guesses of the average distance kept in the field experiment to the expected preferred distance.** This figure plots coefficients obtained from an ordinary least squares regression of the estimate of the average distance kept by subjects in our field experiment on the estimated preferred distance of the experimenter in both Mask and NoMask conditions and the respective 95% confidence intervals. The control variables used in the regressions are the respondents' perception of the sickness/infectiousness of the pictured person, levels of compliance with lockdown measures in the past week, beliefs toward the effectiveness of masks, and demographic information including age, gender, income, household size, political views, and risk attitude. See Table S4 in the Supplementary Materials for the detailed estimation results.

4 Discussion

While policy makers ponder how to best protect public health when easing lock downs, universal use of face masks (i.e. also by healthy individuals) is a prominently discussed option. However, the projected benefits implicitly assume that individuals do not risk compensate and reduce other crucial precautions like physical distancing. This study contributes an important piece of evidence to this debate by studying the effect of face masks on distances kept by others and the drivers behind the observed effect.

Specifically, we develop a field experiment to test whether the use of face masks affects how individuals comply with the public health mandate of keeping a sufficiently large physical distance from other individuals. Using a randomized treatment design, we measure the distance maintained by individuals from an experimenter in a public line waiting to enter a business. In our sample, we find robust evidence that face masks increase distancing. If the experimenter was wearing a face mask, subjects stood on average 9 cm further away than if the experimenter was unmasked. The compliance rate with the distancing mandate of 150 cm increased by more than 10 percentage points from 55% to 67%. We further find that subjects wearing a mask themselves keep a larger distance from the experimenter whereas individuals in groups keep a significantly shorter distance.

Using a complementary survey experiment, our study sheds light on the drivers behind the observed effect. Masked individuals are not perceived as more sick or infectious. However, they are believed to prefer to keep a larger distance from others, which our respondents expect subjects in the field experiment to respect. These results indicate that the effect is driven by social signaling of a preference for distance and compliance with the signal by others.

Our key finding has important implications for the discussion of face covering. In particular, our study suggests that individuals do not let down their guard when someone else is wearing a mask. On the contrary, masks foster efforts to comply with the recommendation of physical distancing. While the observed positive effect may decrease under compulsory masking because the signal of desired distances is weakened, our results provide strong evidence against a harmful negative effect of masks on physical distancing. A field experiment conducted in Italy reports similar results, suggesting that our findings are not pertaining to Germany only (Marchiori, 2020). Our design allows straightforward replications of the experiment in other environments and countries.

A different study design is required to study the effects of wearing a mask on the behavior of the one wearing it, which would be equally important to understand. The challenge we see is that randomization of who wears a mask raises ethical concerns as not wearing a mask may be associated with a health risk. The staggered introduction of mandatory masking policies may provide opportunities to investigate the effects using observational data but may be confounded by simultaneous changes in the public's behavior and perception of risk.

The relevance of our findings lies in the absence of support for the risk-compensation hypothesis. As it is the rationale of most arguments against the community use of face masks, our results can be assessed in the debate based on the growing literature on the epidemiological effects. If medical studies confirm the effectiveness of mask use by the general public and their proper use can be effectively taught, failure of the risk-compensation hypothesis means that there is no reason to discourage public use. As of the writing of this manuscript, this is an ongoing debate. Outside of the context of the COVID-19 pandemic, this paper contributes to the scientific debate about risk compensation by showing that it is not a robust phenomenon in the context of contagion risk.

Author contributions: G.S. developed the original research idea; G.S. and M.S. designed the field experiment; A.B., J.F., and G.S. preregistered the study; A.B., N.C., Y.L., G.S., and M.S. collected data in the field experiment; A.B., N.C., G.S., and M.S. ana-

lyzed, discussed, and interpreted the experimental data – with critical input from A.D., J.F., and Y.L.; A.B., A.D., Y.L., and M.S. designed the online survey; A.B., A.D., and J.F. translated the survey into German; A.D. and Y.L. implemented the survey - with critical input from M.S. and collected the survey data; A.D., Y.L., and M.S. analyzed, discussed and interpreted the survey data; A.B. provided research support for the survey analysis; A.D., J.F., Y.L., G.S., and M.S. wrote the manuscript; all authors revised the manuscript.

Competing interests: All authors declare that they have no competing interests.

Data and materials availability: All data and code for replication will be made available to researchers for purposes of reproducing or extending the analysis upon publication of the study.

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Supplementary Material

S1 Study 1 - Field Experiment

S1.1 Experimental procedures

Throughout data collection, the use of face masks was recommended by the Berlin state government but not mandated.[7] Businesses typically regulated how many customers were allowed to enter their premises at the same time to ensure compliance with the physical distancing mandate. At the time, in Berlin people were required by a state directive to keep a 150 cm distance to non-household members in public spaces.[8] During the period of data collection, the regulatory circumstances did not change.

During data collection, experimenters followed a predefined dress-code and an experimental protocol (see Section S3 for details). Each experimenter collected data in public lines of people waiting to enter a store, supermarket, or post office. Data was collected in daylight to ensure good visibility and on flat surfaces to allow for precise measurements. At the beginning of each data collection, the experimenter determined via a coin toss whether to start with Mask or NoMask. They would switch to the other treatment after a predetermined number of observations and collect an equal number of observations in both treatments.

In the treatment condition, Mask, only FFP2-type face masks were used.[9] We measured and recorded the distance between the arriving next person and the experimenter (see Section S3 for details on the procedure). We estimate the effect of masks on distancing as the difference between the average recorded distances in (Mask) and (NoMask) treatments.

To start data collection, the experimenters took a position at the end of the line, ensuring a distance of 150 cm to the person in front of them, assuming a sideways position in the line. When the next person arrived (the subject), the experimenters recorded the distance between their own and the subject's feet.[10] The experimenter proceeded to the next observation by returning to the end of the line until the predetermined number of observations was reached.

A distance was not recorded if the target subject changed position during the measurement or when the camera view was obstructed by, for example, a sign post. When a group approached the end of the line, distance was measured to the person standing closest to the experimenter. If the closest person was an infant in a stroller or a person

[7] Mandatory use of masks was first introduced in some public spaces in multiple steps starting from April 27, 2020 (Berlin Senate, 2020). Note: The announcement was made after the end of the data collection for the field experiment.

[8] In Germany, most policies were within the discretion of the individual states but the federal government and talks between state governments lead to largely uniform rules. In Berlin, the policies to limit the spread of COVID-19 including physical distancing were regulated through the SARS-CoV-2 Containment Measures Ordinance (SARS-CoV-2-EindmaßnV) on March 22, 2020; the ordinance was changed several times since but not in a respect relevant to the experiment (Berlin Senate, 2020).

[9] An FFP2 face mask or filtering facepiece respirator is a half-face mask that filters the air inhaled by the wearer. Details are specified in the EN 149 standard, an equivalent of the N95 US standard. At the time of data collection, this device was available in pharmacies in Berlin.

[10] The measurement was recorded by an augmented reality application on a mobile device that is able to measure a distance between two points on a flat surface in 1-centimeter increments. To comply with privacy laws, no visual recording was taken.

in a wheelchair, the point used for measurement was where the front wheel touched the ground.[11]

All data was collected in Berlin, Germany, between April 18 and April 24, 2020, by five experimenters, who acquired 60 independent observations each, balanced across the two treatments.[12]

S1.2 Experimental results

Descriptive statistics and randomization checks Our sample consists of independent observations from 300 subjects, 48.7% of whom were male. The majority of subjects were estimated to be between 25 and 45 years old (58.3%). The percentage of subjects entering the line alone was 80.4%, whereas 12.6% were accompanied by at least one adult and 7% were with at least one child. At the time of measurement, 17% of the subjects were wearing a face mask.

Table S1: Randomization check for the field experiment

	Overall (N = 300)	NoMask (N = 150)	Mask (N = 150)	Significant difference between conditions
Male	49%	49%	48%	$\chi^2 = 0.053,\ P = 0.545\ ^a$
14 and under	1%	1%	1%	
Aged between 14 and 25	10%	8%	13%	
Aged between 25 and 35	33%	33%	32%	$z = \text{-}0.421,\ P = 0.674\ ^b$
Aged between 35 and 45	26%	28%	23%	
Aged between 45 and 60	20%	21%	20%	
Aged 60 and older	10%	9%	11%	
Mask Subject	17%	15%	19%	$\chi^2 = 0.591,\ P = 0.269\ ^a$
Company Adult	13%	12%	13%	$\chi^2 = 0.121,\ P = 0.431\ ^a$
Company Child	7%	7%	7%	$\chi^2 = 0.051,\ P = 0.500\ ^a$
Length of line	7.0 (5.2)	7.4 (5.6)	6.6 (4.8)	$t = 1.249\ P = 0.106\ ^c$

Notes: The reported statistics are based on: ^{a} 1-sided Pearson's Chi-square-Test ^{b} 2-sided Mann-Whitney U-Test ^{c} 1-sided T-test. Values in brackets are standard deviations.

[11] Dogs were not included in the study as SARS-CoV-2 has been shown to replicate poorly in canines (Shi et al., 2020).

[12] All experimenters participated in data collection voluntarily and are credited as co-authors of this article. None of the authors were in an employee-employer relationship, mitigating ethical concerns that might arise because time spent in public for data collection during the pandemic may pose a certain health hazard.

S1.3 Kernel density estimates

Using non-parametric kernel density functions, we estimate the distribution of the distance values separately in the two treatments (Fig. S1). A positive shift in distancing can be statistically confirmed (D=0.1933, P <0.01, 2-sided Kolmogorov–Smirnov test) and it demonstrates that the presence of a mask induces individuals to keep a greater distance.

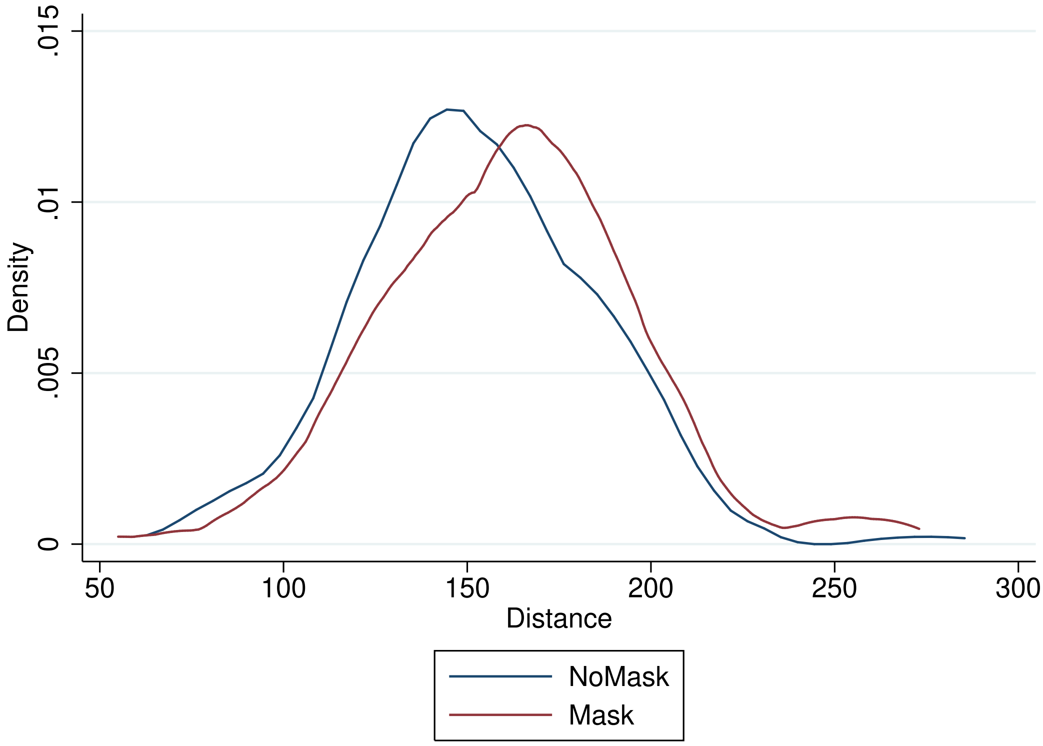

Figure S1: **Kernel density estimates of subject distance.** Estimated univariate Epanechnikov kernel density functions of distance maintained by the subject from the experimenter. The two graphs are calculated separately using the NoMask and Mask treatments.

S2 Study 2 - Survey Experiment

S2.1 Survey design and procedures

The survey was conducted via www.prolific.co. The subject pool was restricted to adult individuals who live in Germany (see Table S2 for the geographical distribution). The survey language was German. The translation of questions can be found below in Section S4). In total, the sample consisted of 463 observations; 7 observations were excluded due to having failed the attention checks leading to a final sample of 456 used for the analysis. The survey lasted on average 8.5 minutes.

The survey participants were paid 2.15 EUR for their participation. An additional bonus was paid for some questions. On average, the bonus amounted to 0.18 EUR. All payments were made via the website of the subject pool provider www.prolific.co.

A key feature of our framework is, that respondents were not only asked their opinion about the possible behavior but also had to predict the most popular answers of other respondents to the same questions. For each correct prediction, the respondents received a bonus of 0.20 EUR.

S2.2 Survey results

Descriptive statistics and randomization checks The average age of respondents in the sample is 28.1 ($SD = 8.2$) years. Of the respondents, 58.77% are male, 8.77% of respondents identified themselves as belonging to the risk group for COVID-19, and a further 2.4% answered they were not sure. The majority of respondents live in North Rhine-Westphalia 21.9% (see Table S2 for the detailed distribution of respondents over German states).

The average household size of the respondents is 2.6 ($SD = 1.82$) persons. The income distribution for the subsample of respondents who provided an answer to the question about their household income is given in Table S3).

Respondents also reported their past compliance with recommended prevention measures. Average compliance on a 6-point Likert scale ranging from 1 'never' to 6 'always' was for hand-washing 4.7 (SD = 1.08), for wearing a face mask indoors 2.2 (SD = 1.38), for wearing a mask outdoors 2.1 (SD = 1.42), and for keeping a 150 cm distance to people they do not share a household with 5.0 (SD = 0.94).

The survey further elicited attitudes toward possible mask mandates using a 5-point Likert scale ranging from 1 for 'highly positive' to 5 for 'highly negative.' A mandate for wearing a mask in public transport was evaluated rather positively (M = 1.83, SD = 0.94). Similarly, mandating compulsory face masks in supermarkets was also evaluated positively (M = 1.8, SD = 0.96). However, a possible mandate to wear a mask while walking outside was perceived more negatively (M = 3.5, SD = 1.21). On average, the respondents indicated that they perceived face masks as being relatively effective in preventing the spread of the coronavirus (M = 2.22, SD = 0.92 on a 5-point Likert scale).

Table S2: Origin of respondents in the online survey by German federal states (in %)

State	Survey sample	Population in Germany in 2018
North Rhine-Westphalia	21.9	21.6
Bavaria	16.7	9.6
Lower Saxony	12.3	15.8
Baden-Württemberg	10.3	13.3
Berlin	9.2	4.4
Hessen	7	7.6
Saxony	4.4	4.9
Rhineland-Palatinate	3.7	4.9
Brandenburg	2.6	3
Hamburg	2.4	2.2
Bremen	2.2	0.8
Schleswig-Holstein	2	3.5
Mecklenburg-Vorpommern	1.8	1.9
Thuringia	1.5	2.6
Saarland	1.3	1.2
Saxony-Anhalt	0.7	2.7

Notes: Column 2 reports the distribution of the respondents' location over the federal states in the survey sample. Column 3 shows the distribution of German population in 2018 over the federal states according to the Federal Statistic Office, https://www-genesis.destatis.de/genesis/online Code "12411-0010".

Table S3: Distribution of the household income in the survey sample (in%)

Income brackets	Survey sample	German households in 2018
less than 1,500	31.2	25.7
1,500 - 2,000	15	15.4
2,000 - 2,600	15.5	15.7
2,600 - 3,200	12.1	11.7
3,200 - 4,500	10.9	16.6
4,500 - 6,000	9.2	8.7
more than 6,000	6.1	6.2

Notes: The distribution of the household income of the respondents in the survey sample is reported in column 2. Column 3 shows the distribution of the income of German households in 2018 according to the Federal Statistic Office, https://www-genesis.destatis.de/genesis/online Code "12211-0105."

S2.3 Additional results

First, we test whether the survey respondents estimate the physical distancing to the pictured experimenter correctly. On average, respondents predicted the subjects to keep a distance of 138.82 centimeters if the pictured experimenter did not wear a mask (NoMask). When the pictured experimenter wore a mask (Mask), respondents on average predicted a longer distance of 144.07 centimeters. However, the difference in estimated distances between Mask and NoMask conditions is not significantly different from 0 (z = -0.777, $P = 0.437$, 2-sided Mann-Whitney U test). The results are qualitatively the same if we use the answers to the hypothetical questions about the distance asked earlier in the survey. In summary, the survey respondents recognized that a face mask did not induce subjects to allow for shorter distances to the masked experimenter, but they underestimated a mask's positive effect on distances kept.

Beyond comparing the public perception of the effect of masks on distance keeping to our field experiment results, the survey contains information to investigate potential driving forces of the experimental results.

The survey responses provide no support for the idea that experimenters who wore a mask are perceived as more likely to be sick or infectious. To the contrary, experimenters in Mask were perceived as less likely sick ($diff = 0.421$, $z = 3.083$, $P = 0.002$, 2-sided Mann-Whitney U test) and as less infectious ($diff = 0.226$, $z = 5.144$, $P = 0$) on a 7-point Likert scale. When asked to predict the perceptions of other survey participants (monetarily incentivized), respondents expected others to perceive the pictured experiments as more sick or infectious than they themselves did (z = -3.976, P = 0.0001, and z = -3.981, P = 0.0001, respectively, 2-sided Wilcoxon signed-rank test). However, the same treatment effect emerges. Respondents in the Mask condition exhibited lower estimates of others' perceived likelihood that the pictured experimenter was sick or infectious than respondents in the NoMask condition (z = 1.981, P = 0.047 and z = 3.631, P = 0.0003, 2-sided Mann-Whitney U test, respectively). Therefore, we rule out the channel that a mask serves as a sign of being sick or infectious.

We perform an ordinary least squares regression of anticipated distances on preferred distances in both the Mask and NoMask subsamples (see S4). The control variables include measures of perception of the sickness/infectiousness of the pictured person, levels of compliance with lockdown measures in the past week, beliefs towards the effectiveness of masks, and demographic variables. In one specification we use respondents' estimated preferred distance of the pictured experimenter as the independent variable of interest and in the other we use their beliefs about the average estimate of other respondents on the preferred distance.

Table S4: Responsiveness of estimated distance in the field experiment to preferred distance

Panel A				
Estimated preferred distance	0.234***	0.450***	0.071	0.384***
	(0.071)	(0.076)	(0.074)	(0.082)
Subsample	NoMask	Mask	NoMask	Mask
Control variables	No	No	Yes	Yes
Observations	228	228	226	226
R-squared	0.046	0.133	0.308	0.293
Panel B				
Beliefs about others' average Estimated preferred distance	0.356***	0.447***	0.271***	0.431***
	(0.067)	(0.080)	(0.073)	(0.082)
Subsample	NoMask	Mask	NoMask	Mask
Control variables	No	No	Yes	Yes
Observations	228	228	226	226
R-squared	0.110	0.121	0.352	0.311

Notes: Ordinary least squares estimates. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table shows detailed estimation results obtained from a linear regression of the estimated average distance kept by subjects in our field experiment on estimated preferred distance of the experimenter in Mask and NoMask conditions. We use two different measures for the estimated preferred distance as the independent variable of interest. In panel A, we obtain the preferred distance as the survey respondents' own estimations. In panel B, we instead use their beliefs about the average estimate of other respondents about the preferred distance. In all regression, the control variables are the respondents' perception of the sickness/infectiousness of the pictured person, levels of compliance with lockdown measures in the past week, beliefs toward the effectiveness of masks, and demographic information consisting of age, gender, income, household size, political view, and risk attitude.

S3 Protocol for the field experiment

Disclaimer: *The experimenters who collected data in the field experiment signed up to do so voluntarily and confirmed that they did not belong to any risk group. In order to prevent imposing health risks on others, the Robert Koch Institute's health recommendations were strictly followed at all times of the experiment.*[13]

Introduction

The instructions for recording the data follow. Please read the whole document and follow all points very carefully.

Code of Conduct

Experimenter Appearance

As an experimenter, you will need an FFP2 respiratory protection mask for this experiment. **Each time before** you go to an experiment location, you will take two full-body (self-)portrait photos of yourself: One with and one without a mask. The primary purpose of the photos is to record variables describing your appearance if this is requested by the reviewers. To decrease the noise due to experimenter appearance, you are expected to wear a pair of blue jeans and a dark-colored (black, dark gray or navy blue) top without any visible text or logo.[14]

Location You may choose a location that satisfies the following list of conditions.

- The establishment is an open supermarket, a drug store (except pharmacy) or a post office.
- There must be a waiting line outside with people waiting to enter the store. The waiting line must stand on a flat surface with no obstructing objects. Make sure that the waiting line is clearly visible and it is clear for the arriving subject that you are the last person in the line and approximately where they should stand.
- You can record the data anytime until April 24 between 8am to 8pm during daylight with good visibility. In order to secure good visibility conditions, **do not** record data when it is raining.
- You should avoid stores that have heavy traffic that would make measurement difficult. For instance, if there is another store or a subway exit next door, people in the waiting line might change their position frequently, making recording data problematic.
- The time gap between people who are let into the store must be sufficiently long. The measurement may take a couple of seconds, and you may be asked to move forward if the waiting line moves; the subject can also move before you can record the distance between you. The speed is usually smaller at post offices than at supermarkets.

[13]The Robert Koch Institute (RKI) is the government's key scientific institution in the field of biomedicine. It is one of the central bodies for the safeguarding of public health in Germany. See `https://www.rki.de/`.

[14]Please consult us if you do not own these items.

Data Recording Method You will need a smartphone with an installed augmented-reality tape-measure app that is capable of measuring small distances in centimeters with small measurement errors. The error is measured individually on the same device you use on location. Place two flat objects on the ground at any location with a clear surface exactly 100 cm from each other. Similarly to the protocol on location, measure this distance with the application. Do the same measurement five times with different positions of the objects. You may proceed with this hardware and application if the error is within a 3% margin every time.

Preparation for Data Recording In total, you are expected to perform 60 independent observations. Before each session, you set an even target of observations you are planning to record. Half of them you execute with, the other half without your mask on. The order you decide randomly using a fair coin or any random number generator. Example: You set the number to 20. After tossing the coin, you start with 10 observations with your mask on. After finishing with this, you remove the mask and perform another 10 without it. Finally, you leave the location.

The purpose of changing your appearance only once is to limit the number of times you may accidentally touch your face. You can safely avoid this if you remove the mask by only touching the strings. You should proceed the same way if you start your work without your mask on. To learn about the safe way to wear a mask, please consult the website of the Robert Koch Institute.

Data Recording Procedure Due to lockdown measures in place, you will work alone and record the data individually. After choosing the location, go to the end of the waiting line outside and carefully follow this protocol.

1. Go to the waiting line and stand 150 centimeters (1.5 meter) away from the last person.[15] Measure the distance using the same application.
2. Turn sideways, not facing either the waiting line nor the subject arriving after you. Make sure that you can see both.
3. If necessary, calibrate your application such that it is ready for measurement. Do not open other applications at this point.
4. If someone approaches, turn your back to the waiting line and face the subject before they arrive. Make sure that your face is visible, but look at your device the whole time. Keep a neutral facial expression and do not make eye contact.
5. The app measures distance by pinning two points on the ground. These two points are the closest points of yours and the subject's shoes. You pin the tip of their shoe first when they arrive, and the tip of your shoe second.
6. Record the length and exit the waiting line.
7. After this, record all remaining variables, starting with the number of people in the waiting line who were standing before you outside at the point of measurement.

[15] Recommended minimum safe distance by the Federal Government of Germany and the Robert Koch Institute.

After this, go back to the end of the waiting line until you reach your target number of observations.

Further Points to Consider

If there is a group, the subject is the person closest to you, irrespective of age. Exceptions: If the closest person is an infant in a stroller or a person in a wheelchair, the closest point is where the front wheel touches the ground. If this reference point belongs to a stroller, the person you record is the one handling the stroller.

Do not record an observation if you are unable to pinpoint the position of the subject accurately (i.e., the subject might keep jogging in place, or move back or forward before you can finish pinning) or if the subject engages in an activity that would trigger distancing according to local social norms (i.e., smoking, talking on the phone, eating).

There are three time slots per day: morning 8am-12 noon, afternoon 12 noon-16pm, and late afternoon/early evening 4pm-8pm. Do not record more than 50% of the observations in one period of time (e.g., morning), even if they are recorded on different days.

Do not attempt to make any media recording of the subject or any other individual near you as without consent this may be unwelcome. If you meet with a hostile or unfriendly reaction or you are questioned by someone, you can reveal your identity and that you are conducting a publicly funded scientific study. If this hinders or influences recording data, or puts you in an uncomfortable situation, leave the location.

Data and Variables

In this part, you can find the list of variables with the corresponding codes. Your task is to complete the spreadsheet for each observation. You will receive the spreadsheet by email. Once you have finished recording, send the file to gyula.seres@hu-berlin.de.

MaskE	Treatment variable. Experimenter 0=without 1=with mask.
Distance	Distance to the subject. Measured in centimeters (cm).
GenderS	Binary virable. Subject gender 0=male 1=female.
AgeS	Guessed age category of the subject. 0= below 14, 1=14-25, 2=25-35, 3=35-45, 4=45-60, 5=60+. If it is uncertain, write your best guess.
MaskS	Binary variable. Subject 0=without 1=with mask.
CompanyAdult	Number of accompanying adults, 0=no adult. Adult, if age>14.
CompanyChild	Number of accompanying children, 0=no child. Child, if age<14.
TotalNumofPeople	The total number of people outside in front of you in the waiting line at the moment of measurement. Do not include people inside.
SocialNormS	The presence of social norm violations (i.e., smoking, food, other).

Address	Address of the experiment. For example, "Spandauer Strasse 1, 10178."
Store	Type of the store. 1=post office, 2=supermarket, 3=drug store, 4=other (please add a note)
ID	Surname of experimenter.
Date	Date of the month. For example, if the date is April 20, write 20.
Time	Time (i.e., 1400, 1430, etc.).
Note 1	Additional remarks, may be left empty.
Note 2	Additional remarks, may be left empty.

S4 Survey questionnaire

The original survey was written in German. Below, we provide an English translation. We structure the text with informative subheadings that were not part of the survey text that respondents saw.

Welcome to this study on judgment and decision-making. This survey will take 15 minutes of your time. Every person who completed a survey, including you, will receive 2.15 EUR for participation. The payment will be processed via prolific.co and done automatically. Please read all questions carefully and answer them truthfully.

Introduction of the picture Below, you can see a picture of a person in front of the post office. Please answer the following questions with regard to the picture you see.

- To which extent do you agree,

  ...that the person pictured looks relaxed?

  ...the person pictured looks tidy?

  ...the person pictured looks friendly?

  1 "strongly agree" 2 "moderately agree" 3 " agree a little" 4 "neither agree nor disagree" 5 "disagree a little" 6 "moderately disagree" 7 "strongly disagree"

- Have you seen this person before? Yes / No / Maybe

Opinion about the preferences and the health condition of the person (not) wearing a mask, the effectiveness of masks for distancing

Imagine the following situation: The person you saw in the photograph at the beginning of the survey is standing in a waiting line outside of a post office. Now another person (who is interested in getting into the post office) approaches the end of the waiting line.

- In your opinion, at which distance will the person approaching come to stand behind the person in the photograph. Please indicate the distance in centimeters below (100 cm = 1 m).

- What do you think is the minimum distance the person in the photograph would like the person approaching the waiting line to keep from her/him while waiting in line outside a post office? Please indicate the distance in centimeters below (100 cm = 1m).

- In your opinion, how likely is it that the person in the photograph is infectious for other people in the waiting line? Please choose one answer from 1 to 7. 1 "definitely not infectious" 2 "very unlikely to be infectious" 3 "somewhat unlikely to be infectious" 4 "I don't know" 5 "somewhat likely to be infectious" 6 "very likely to be infectious" 7 "definitely infectious."

- In your opinion, how likely is it that the person pictured is sick with the coronavirus, the flu, or another virus-related respiratory diseases? Please choose one answer from 1 to 7. 1 "definitely not sick" 2 "very unlikely to be sick" 3 "somewhat unlikely to be sick" 4 "I don't know" 5 "somewhat likely to be sick" 6 "very likely to be sick" 7 "definitely sick."

Introduction of the bonus rules

In the upcoming part of the survey you will be able to earn some additional bonus payment. You will be asked to estimate the average or most frequent answers of other survey participants. For each correct guess, you will receive an additional payment of 0.20 EUR (20 cents). More details about the rules for bonus payment will be given below.

Please enter your Participant ID here if you would like to receive the payment. It will be used for payment purposes only. After the payment has been made, it will be deleted from the data set.

Incentivized beliefs / Descriptive social norm elicitation

Other survey participants were shown the same photograph as you at the beginning of the experiment and were asked the same questions as you.

All participants saw the following situation description: "Imagine the following situation: The person you have seen in the photograph at the beginning of the survey is standing in a waiting line outside of a post office. Now another person (who is interested in going into the post office) approaches the end of the waiting line."

Please estimate the average answers to the following two questions by 50 randomly selected individuals. Think about your answer thoroughly, because for each guess that does not deviate from the actual average answer of 50 other participants by more than 5 cm, you will receive an additional bonus of 0.20 EUR.

- What is the average answer of 50 other randomly selected participants to the following question: "At which distance will the arrived person come to stand behind the person in the photograph." Please guess the average answer to this question:
- What is the average answer of 50 other randomly selected participants to the following question: "What is the minimum distance this person would like the next person in the waiting line to keep from him/her while waiting in line outside a post-office?." Please guess the average answer to this question:

Now, we would like you to estimate the most frequent answer among 50 randomly selected participants of this survey. Think about your answer thoroughly, because for each correct guess you will receive a bonus of 0.20 EUR.

- What is the most common answer among 50 randomly selected survey participants to the following question: "How likely is it that the person in the photograph is infectious for other people in the waiting line? (From 1 to 7)" Please guess the most common answer to this question: 1 "definitely not infectious"; 2 "very unlikely to be infectious"; 3 "somewhat unlikely to be infectious"; 4 "I don't know"; 5 "somewhat likely to be infectious"; 6 "very likely to be infectious"; 7 "definitely infectious."
- What is the most common answer among 50 randomly selected survey participants to the following question: "How likely is it that the pictured person is sick with the coronavirus, the flu, or another virus-related respiratory disease? (From 1 to 7)" Please guess the most common answer to this question: 1 "definitely not sick"; 2 "very unlikely to be sick"; 3 "somewhat unlikely to be sick"; 4 "I don't know"; 5 "somewhat likely to be sick"; 6 "very likely to be sick"; 7 "definitely sick."

Estimation of the experimental results

Last week we ran a study in which we measured the distance that individuals keep at the end of a waiting line from another person. The study was done in Berlin in a line for the post office. The last person in the waiting line was an experimenter, who you saw in the picture at the beginning of the survey.

Please guess the average distance 30 individuals kept from this person.

Think about your answer thoroughly, because you can earn an additional bonus based on the correctness of your guess. If your guess does not deviate from the actual average distance from our study by more than 5 cm, you will receive an additional bonus of 0.20 EUR.

- Please guess the average distance kept away from the experimenter by 30 individuals approaching him/her at the end of the waiting line:

Attitude towards masks and mask-wearing behavior

- How do you evaluate the introduction of the compulsory wearing of face masks in public transport in Germany? 1 "very positive"; 2 "rather positive"; 3 "undecided"; 4 "rather negative"; 5 "very negative."
- How do you evaluate the introduction of compulsory wearing of face masks in supermarkets? 1 "very positive"; 2 "rather positive"; 3 "undecided"; 4 "rather negative"; 5 "very negative."
- How do you evaluate a possible introduction of compulsory wearing of face masks while walking outside? 1 "very positive"; 2 "rather positive"; 3 "undecided"; 4 "rather negative"; 5 "very negative."
- In your opinion, to what extent are face masks effective for preventing the spread of coronavirus? 1 "very effective"; 2 "somewhat effective"; 3 "I don't know"; 4 "not very effective"; 5 "not effective at all."
- In the last week, how often did you : (1 "never" to 6 "always")

  wash hands with soap for at least 20 seconds.

  wear a face mask in indoor areas

  wear a face mask in outdoor spaces

  keep a distance of at least 150 cm to people who are not living in your household.
- There are some groups of people who are at particular risk of developing a serious disease due to infection with the coronavirus. These groups include people who are over 65 years of age, have a weakened immune system, or have a relevant underlying medical condition (e.g., chronic diseases of the respiratory system, diabetes, cardiovascular diseases, cancer). Do you belong to a coronavirus risk group? Yes/No/Maybe.

Past experience with coronavirus-related survey

- How many times have you participated in surveys about COVID-19 / coronavirus in the last 4 weeks? Scale 0 to "10 or more."

- How many times have you taken part in surveys about face masks in the last 4 weeks? Scale 0 to "10 or more."

Attention check

- Does the person you saw at the beginning of the survey wear a mask? Yes/No
- What is this person's hair color? (Multiple choice: Blond/Brown, etc)
- Was this person standing or sitting?
- What is the gender of the pictured person? male/female

Demographic questions

Please answer the following questions about yourself:

- How old are you?
- What is your gender? male/female/diverse
- Do you live in Germany? yes/no
- In which federal state do you live? (Choice from a drop-down menu)
- Are you, in general, a risk-loving or risk-averse person? (1=not risk-loving at all, ..., 10=very risk-loving)
- How many people live in your household (including yourself)?
- What is your average monthly net household income? "Less than 1,500 EUR", "Between 1,500 EUR and 2,000 EUR", "Between 2,000 EUR and 2,600 EUR", "Between 2,600 EUR and 3,200 EUR", "Between 3,200 EUR and 4,500 EUR", "Between 4,500 EUR and 6,000 EUR", "6,000 EUR or more", "I don't want to answer this question"
- Which party would you vote for if the Bundestag elections were on Sunday in Germany? SPD / CDU / CSU / FDP / Bündnis 90 (Die Grünen) / Die Linke / AfD / NPD(Republikaner / Die Rechte) / Other / No answer
- Is German your native language? yes/no

Survey comprehension and comments

- Did you have problems understanding the survey? yes/no
- If so, what exactly were you not clear about? (text box)
- You can leave us a comment or a suggestion here. (text box)

Thank you for your participation, you have reached the end of the survey! Your payment will be processed automatically. If you are eligible for the additional payment, you will be notified within 72 hours.